I. C. 6724 JUNE, 1933

DEPARTMENT OF COMMERCE

UNITED STATES BUREAU OF MINES
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INFORMATION CIRCULAR

PROTECTIVE CLOTHING IN THE MINING INDUSTRY

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R. D. CURRIE AND W. J. FENE

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DEPARTMENT OF COMMERCE - BUREAU OF MINES

PROTECTIVE CLOTHING IN THE MINING INDUSTRY[1]

By R. D. Currie[2] and W. J. Fene[2]

The value of protective clothing in the prevention of injuries has long been recognized in many of the leading industries, but the adoption of the idea into mine safety programs is comparatively new. Once started, however, the idea has grown rapidly and the results already obtained by mining companies have shown that it is fundamentally sound.

Both coal and metal mining companies are rapidly adopting these protective measures, and since 1924 many mines have become well equipped with eye, head, and foot protection. At the present time approximately 70 percent of the employees in the anthracite mines of Pennsylvania are provided with safety hats. At many metal mines all employees are provided with safety hats, shoes, and goggles. The Pennsylvania mining law provides that all shaft workers in anthracite mines shall wear protective hats.

According to a study[3] made of the nature of 3,485 temporary injuries and of the parts of the body of underground coal mine employees most exposed to occupational hazards, the head and face were injured 665 times, the hands 856 times, and the feet 565 times. Of 2,555 temporary injuries in metal mines, the head and face received 484, the hands 788, and the feet 357. In a similar study[4] made by a coal-mining company for the year 1928, of 556 injuries the scalp received 9, the skull 4, the eyes 47, the hands 62, the thumbs 21, the fingers 141, the ankle 7, the feet 51, and the toes 35. Probably most of these injuries could have been prevented by suitable protective clothing and equipment. This study also revealed that at least one injury occurred in each of the 34 classifications of workers employed at these mines.

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1 The Bureau of Mines will welcome reprinting of this paper, provided the following footnote acknowledgment is used: "Reprinted from U. S. Bureau of Mines Information Circular 6724."

2 Associate mining engineers, safety division, U. S. Bureau of Mines, Pittsburgh Experiment Station, Pittsburgh, Pa.

3 Adams, W. W., Mine Accident Statistics: Rept. of Investigations 2641, Bureau of Mines, September, 1924, pp. 26, 27, 49-50.

4 Currie, R. D., Coal Mine Safety Organizations in Alabama: Technical Paper 489, Bureau of Mines, 1931, p. 34.

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In addition to being most numerous, injuries to the parts of the body previously named are the most easily prevented by suitable clothing and equipment. Therefore the use of protective clothing is becoming popular with those companies who have made a study of its advantages.

EYE PROTECTION

Eye protection was probably the first safety need to be considered, and, as was natural, the type of protective goggles first adopted by the mining industry were of the type in use in other industries. As might be expected it was soon found that goggles suitable for the mill or shop were not necessarily suitable for mining. Many complaints were received from the men that the goggles fogged, obscured the vision, or were too heavy for continuous wear. These complaints usually were well founded, and considerable work had to be done in developing goggles suitable for the mining industry. To be satisfactory, goggles should be light in weight, well ventilated, rugged, optically true, and should allow a wide angle of vision, if their voluntary use by the miner is desirable. Strict discipline might cause employees to wear goggles with undesirable characteristics, but eye injuries are likely to continue to occur where such compulsory measures are necessary.

Some objections have been made to the use of goggles by underground employees on the grounds that the wearing of goggles would expose the workmen to other hazards and indirectly bring about more serious injuries from other causes. This theory has not been substantiated, as is shown by one large coal company which has made a close study of the factors entering into the use of goggles and whose experience over a period of 4 years has been that as far as could be ascertained not a single injury from other causes was attributable directly or indirectly to the wearing of goggles.

There are many types of safety goggles on the market, but the rigid type, provided with shatterproof lenses, appears to be best suited for underground workers and is the type most generally worn. In some cases corrective lenses have been provided for those having defective vision; this very good practice should unquestionably be extended and ultimately be universal. While full vision for underground workers is probably even more necessary than for workers in surface industries, there are few workers who wear ordinary eyeglasses underground to correct defective vision. It has been found that a large percentage of industrial workers have defective vision, and there is no doubt that the providing of corrective lenses in goggles would not only protect the eyes from flying particles, but due to the better vision provided, would also help to prevent accidents from other causes. To obtain the maximum benefit from the use of goggles, they should be worn during the entire shift, or from the time the workmen enter the mine until they leave; this is seldom required and is done only in rare instances, but there is no question that it is advisable. Goggles also should be worn by surface employees when engaged in any work where particles are liable to fly into the eyes, such as grinding, chiseling, or hammering iron or steel.

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HEAD PROTECTION

Head and scalp protection is a problem that probably concerns the miner more than any other worker, and for this reason it is only natural that the development of head protection has been almost exclusively for the mining industry. The first protective headgear was, undoubtedly, a padding of cotton waste stuffed into a miner's cap or felt hat. The present protective hats and caps are such a vast improvement over former makeshift headgear that the mining industry is adopting the new type with considerable rapidity. The first step in the development of a protective hat in metal mining was to use a steel hat or helmet like that which protected the soldiers in the Great War, and the first in coal mining was to stuff the hat with cotton waste. Later developments, however, have provided a hard hat with a cushioned lining to absorb the force of a direct blow and allow ventilation, which is satisfactory for the use of both coal and metal miners.

The types of protective hats and caps now in use are constructed of hard insulating material that will withstand a hard blow or a high-voltage electric current; they are moisture- and acid-proof and are made in various styles to meet various mining needs. They will prevent many injuries that might otherwise prove serious or fatal. It is important that the wearer procure the proper size for his head and that the cushion be properly adjusted.

Objections were made to some of the first protective hats introduced for the reason that they were heavy and uncomfortable to wear. These objections have been overcome and the hats now manufactured are lighter in weight, better ventilated, and are worn with little or no discomfort.

The experience of many companies is that protective hats are preventing fatal as well as less serious accidents. One company is now mining four times as much coal per head injury as it did before it introduced protective hats. Another company reduced its compensation and medical cost due to head injuries approximately $7,500 in 4 years' time by the use of protective hats. It is generally found that as the number of protective hats increase at a mine the number of head injuries decrease.

TOE PROTECTION

Toe protection has been difficult to arrange, primarily because miners, in general, have been in the habit of wearing shoes for work that are no longer suitable for street wear, and are reluctant to purchase special shoes for work. Another drawback is the fact that many of the protective shoes introduced into the industry are not properly constructed to give comfort to the wearer; this is not so noticeable in work shoes lacking the stiff box toes, but is accentuated when stiffness is added. Another drawback to the voluntary adoption of foot protection is the limitation in the selection of lasts offered by the shoe manufacturer; in general, only wide-last shoes are available to the prospective purchaser of safety shoes, and it is improbable that more than half the men in the industry can be properly fitted in the

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shoes now available. This, however, is a difficulty that can be easily remedied through proper cooperation between mining companies and shoe manufacturers. Proper designs in rubber footwear having protective toes have apparently given more difficulty than leather footwear, but most of these difficulties are also caused by the lack of selection in sizes and widths.

Due to the nature of the material handled and the increasing use of machinery, the need for foot protection for underground employees is urgent. Protective shoes have prevented many toe injuries due to falling or rolling coal, rock, ore, and timbers, and from wheels of moving cars and machines, and their use in and around mines should be universal.

OTHER TYPES OF PROTECTIVE CLOTHING

Other types of protective clothing that are required by some companies are gloves, leggings or high-cut boots, and safety belts.

A study of the percentage of accidents happening to fingers and hands indicates that some type of suitable protection should be given to these accident-prone parts of the body. There have been so many accidents, however, traceable to the use of certain types of gloves and to the injudicious use of gloves near fast-moving machinery, that great care must be exercised in adopting this mode of protection to prevent hand and finger accidents. The suitable type of glove when properly used should, however, prevent many small hand and finger injuries. Infections from small cuts have been greatly reduced in mines where the use of gloves is required.

Leggings, high-cut boots, or snug-fitting trouser legs undoubtedly afford real protection to mining employees who are constantly working in close proximity to moving cars, locomotives, conveyors, and other machinery and equipment. Employees should not be permitted to endanger themselves by wearing loose or baggy clothing, ragged sleeves, or loose neckties.

Safety belts are needed only in certain types of mining and under certain conditions of work, so that they will never be used generally; their use, however, where the conditions require them, as in glory holes, steep banks in opencuts, and similar places, is a real safety factor that should not be overlooked.

In addition to these widely used items of protective clothing, certain companies require employees working in unusually hazardous occupations to wear special protective clothing. Wiremen in many mines are required to wear rubber gloves, rubber shoes, or both while working on power and trolley lines. Haulage crews in some Alabama coal mines are required to wear shoes having rubber inner soles to insulate against electric current, while at least one company requires the use of a foot guard to prevent injuries to the feet of some of their tipple crew. Some companies that load coal direct from the tipple into river barges require the barge tenders to wear life belts.

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COST AND DISTRIBUTION

The initial cost of installing protective clothing is an important item and is generally a controlling factor in the selection of types of protective clothing adopted or a deciding element in whether such protection is adopted.

Other questions of cost and distribution which confront every company considering the adoption of such protective devices are:

1. Who should pay for this protection, the company or the employees?

2. How should distribution be made?

3. How can the company expect a fair return for its money if it furnishes these protective devices?

4. How can the miner expect value for money paid if he is required to purchase them?

5. Should the use of such equipment be voluntary with the workmen or made compulsory?

1. Expense. - The first of these questions is perhaps the most difficult to answer and is often the criterion as to the success or failure of the protective-clothing program. Some companies have answered it by furnishing certain items of protective clothing while requiring the employees to purchase the others. Recent legislation in some mining States has made it compulsory for certain employees to be equipped with protective clothing, while the compensation rating schedules of other mining States have made it worth while to have all employees equipped with certain items of protective clothing. In any event, both the employer and employee are protected by the general use of these devices, and it seems only reasonable that both should share in their initial cost.

2. Distribution. - The second question is one that should cause little difficulty because most mining companies already have a distribution system for general mine supplies and needs for their employees, so that little difficulty should be encountered in adding these items to their stock. There are many advantages in this form of handling these items; the most important one is the control afforded the company in checking the type of equipment supplied to their men, and secondly, the assurance of a fair price for items purchased by the men.

3. Value to Company. - The answer to the third question depends upon several factors. The savings made in compensation and medical cost will usually more than cover the cost of such equipment. A recent report from a coal-mining company shows that over a period of one year the records indicate that it saved $1,244 in head injuries through the use of protective hats among 2,113 employees.

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Another coal-mining company reports that among 250 underground employees and 43 surface employees they have realized a saving of $9,972 by decreasing head injuries and of $1,848 by decreasing foot injuries through the use of protective hats and safety shoes. A third coal-mining company reports that among 140 underground and 60 surface employees it saved in compensation and medical cost $2,967 in one year through the use of protective hats, shoes, and goggles. In some States the compensation cost for the loss of one eye is $2,000, an amount which would buy many goggles. These examples would indicate that any mining company can feel assured that money spent in furnishing its employees with protective clothing very probably will be more than repaid in decreased accidents, lower compensation rates, savings in compensation and medical care, and in a better functioning organization.

A recent announcement of the Pennsylvania Compensation Rating and Inspection Bureau indicates that a credit of 8 cents per $100 of pay roll will be allowed where all underground employees wear approved types of protective hats or caps. Under this schedule a credit of 5 cents is made for the use of goggles and a credit of 5 cents for the use of safety shoes, where all employees wear this type of protection as specified.

4. Value to miner. - The miner can expect fair value for money paid for protective clothing in addition to the protection it affords him. Protective hats will outwear most of the ordinary mining caps; protective shoes are no more expensive than ordinary work shoes, and in many instances where they are sold by the company direct to the workmen they are actually cheaper.

5. Voluntary or Compulsory use. - Whether the adoption of protective items of clothing should be voluntary by the workmen or made compulsory by the company depends upon the company organization and the type of workmen. It also depends to some extent upon the answer to the question "Who should pay for protective clothing?" Voluntary wearing of the equipment is highly desirable and can generally be obtained through education and example, both of which are entirely in the control of the operator. If the employee will not take steps to protect himself, however, then adoption of protective clothing should be made compulsory and strictly enforced.

SPECIFICATIONS

The Bureau of Mines has no specifications covering the design of hats, goggles, gloves, and shoes, nor is it likely to formulate schedules of tests or give approval to these items of wearing apparel. Some mining companies have given various makes of hats thorough trials to determine which is the most suitable for their conditions. Definite specifications for safety hats or caps, goggles, and shoes have been set up by the coal mine section, Pennsylvania Compensation Rating and Inspection Bureau, Harrisburg, Pa., as follows:

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Specifications for Safety Hats or Caps

Definition:

The term "safety hat or cap" shall mean any hat or cap, by whatever name it may be known, that is made of such material and in such a manner so as to afford protection to the head from blows, falling objects, electric shock, etc., and be worn by men at work with a reasonable degree of comfort.

A - Types:

The Bureau believes the responsibility for selecting the particular type of hat or cap to be used should rest with the coal operator. The following types will be accepted, provided they meet the specifications set out below:

A-1. Hats or caps with a complete brim.
A-2. Hats or caps with one or more visors.
A-3. Any combination of a hat or cap.

B - Materials and Workmanship:

B-1. Materials used in the manufacture of a safety hat or cap shall be suitable for the particular type, light in weight, water-resisting, acid-resisting, and durable.

B-2. The materials of the lining and the hammock or cradle shall be of the best quality and strength. The assembly shall be so as to give the maximum protection and comfort to the wearer.

C - Construction:

C-1. All parts of a safety hat or cap shall be so assembled that those parts coming in contact with a man's head shall have a dielectric strength to withstand 750 volts for at least one (1) minute.

C-2. The lining of a safety hat or cap shall be so assembled that there shall be a cradle or hammock to support the complete hat or cap on the wearer's head. This cradle or hammock shall be constructed so as to be fully adjustable. When this cradle or hammock is properly adjusted, there shall be at least one (1) inch of space between the top of the wearer's head and the top of the inside of the crown. It shall be affixed to the hat or cap in a strong and substantial manner.

C-3. The safety hat or cap shall be so constructed as to comply with the following test: When mounted on a wood block similar to the position on a man's head, it shall withstand a pressure blow from an 8-pound iron ball (approximately 4 inches in diameter)

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dropped vertically on to the center of the crown from a height of five (5) feet without denting or breaking sufficiently to touch the wood block. The cradle or hammock shall withstand the impact from this same blow without breaking or forcing hat or cap down over the head.

C-4. All safety hats or caps shall be fire-resisting.

C-5. The safety hat or cap shall be so designed and constructed as to give the required protection and be worn with a reasonable degree of comfort.

Specifications for Safety Goggles

Part I. Eyecups and Spectacle Goggles.

Part II. Wire Screen Goggles.

Part III. Use.

Part I. Eyecups and Spectacle Goggles

A - Types:

The Bureau believes the responsibility for selecting the particular type of goggle to be used should rest with the coal operator. The following types will be accepted, provided they meet the specifications set out below:

A-1. The cuptype goggle and/or its modifications.

A-2. The spectacle-type goggle and/or its modifications.

B - Materials and Workmanship:

B-1. Materials used in the manufacture of goggles shall be suitable for the purpose, of enduring quality, capable of being sterilized without deterioration, and non-irritating to the skin when subject to perspiration.

B-2. All metal materials used shall be corrosion-resistant.

B-3. Nitrocellulose or materials equally inflammable shall not be used.

B-4. Materials used shall be such as to combine mechanical strength and lightness of weight to a high degree and workmanship shall be the best throughout.

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B-5. Where cup-type goggles are used, the cups shall be ventilated. The edge of the eyecup shall form a cushion at least 3/16 inch in facial contact width and shall be so designed as to prevent cutting of the face. If metal eyecups are used, the facial contact edges shall be bound with a cushion at least 3/16 inch in facial contact width and shall be so designed as to prevent cutting of the face by contact with the metal cup edge. This binding shall be non-flammable.

B-6. Head bands shall be of good grade, at least 3/8 inch wide. They shall be adjusted to length and shall be fastened to the eyecups or goggle in such a manner as to be easily replaced and shall not interfere with the facial fit of the eyecups.

C - Lenses:

C-1. All lenses shall be made from a single solid glass plate of a quality suitable for optical use and shall be capable of passing the test as to quality, visibility, and shock resistance of the Bureau of Standards of the Federal Government.

C-2. The strength of all lenses shall be such as to comply with the drop-ball tests as required by the Bureau of Standards in the Federal Government specifications.

C-3. The optical surfaces of all lenses shall be free from visible surface defects. They shall be ground or polished on both sides. They shall not be effectively out of parallel. All lenses shall be suitable for continuous use by the wearer without discomfort or optical impairment to the normal eye.

C-4. All lenses in every type of goggle or eyecup shall bear some permanent distinctive marking by which the manufacturer may be readily identified.

D - General:

D-1. The specifications herein set out as Part I are abridged from the Federal Government's "Federal Specifications for Goggles: Eyecup, Chippers" as set out in Circular GCG-G-501, December 9, 1930. Any question of dispute that may arise from the interpretation of these standards shall be decided in accordance with the detailed specifications as set out in the Federal Government specifications referred to. It is recommended that persons interested in the use of goggles write to the Superintendent of Documents, Washington, D. C., and procure a copy of these Federal specifications. The price is $.05.

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Part II. Wire-Screen Goggles

Note:- It has been found by experience that wire-screen goggles have not been a permanent installation in either mining or industries other than mining where goggles have been used for some long time. Usually, it is the first type considered. Probably the low initial cost may contribute to this. Many users of goggles who originally started with wire screen goggles later discarded the same for the spectacle or eyecups. However, the Bureau feels at this time that the wire-screen goggle should not be excluded, even though the other types are preferred, and therefore the following specifications covering wire-screen goggles are submitted:

A - Types:

A-1. Cup type.

A-2. Spectacle type.

A-3. All-wire type.

B - Materials:

B-1. The material used in wire-screen goggles shall be of noncorrosive wire not more than 0.016 inch in diameter and shall have not less than 20 strands to the inch.

C - Construction:

C-1. Cup-type or spectacle-type wire-screen goggles, other than the lens part, shall conform to the specifications approved for eyecups and spectacle goggles. The wire screen shall be inserted into the eyecup or spectacle frame, as the case may be, in such a manner that the ends of the wire cannot come in contact with the eye or face.

C-2. The all-wire screen goggle shall be die cut and shaped to fit the contour of the face. It shall have a firm binding around the edge so that there may be no danger of loose wire strands coming in contact with the eye or face. The head bands shall be adjustable.

Specifications for Safety Shoes

Definition. The term "Safety Shoe" shall mean any shoe, boot, or pac that has a protective toe cap inserted in the toe so as to give a reasonable amount of protection to the foot.

A - Types:

The Bureau believes the responsibility for selecting the particular type of safety shoe to be used should rest with the coal operator. The following types will be accepted, provided they meet the specifications set out below:

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A-1. Leather shoe, boot, or pac.

A-2. Rubber shoe, boot, or pac.

A-3. Any combination of leather and rubber shoe, boot, or pac.

B - Materials and Workmanship:

B-1. Materials used in the manufacture of 'safety shoes' shall be suitable for the particular type and of high grade so as to give the maximum service.

B-2. The protective toe cap shall be constructed of material which will not be affected by heat or moisture conditions.

C - Construction:

C-1. The protective toe cap shall be so inserted in the shoe that it becomes an integral part of the shoe and shall not be a floating cap or what may be styled an appendix to the original shoe.

C-2. The protective toe cap shall be arched or shaped and inserted so as to withstand at least 350 foot-pounds pressure without crushing.

C-3. The protective toe cap shall be large enough to cover at least three (3) toes.

Note: Some protective toe caps are arc-shaped and long enough to cover all five toes.

REPORTS OF LIVES SAVED OR INJURIES PREVENTED

During the past few years the Bureau of Mines has received scores of reports indicating that lives have been saved or injury prevented through the use of protective clothing in mines. A few typical examples of these reports are given here because it would be impracticable to enumerate all of them in a report of this kind. It is impossible to estimate the number of injuries prevented by the use of protective clothing; unless an injury is received, the occurrence of a near-accident does not get into the record through the medium of an accident report and is, therefore, seldom known except to the person affected.

1. At - - - - - , the life of Mike - - - - - , machine runner, was saved because he wore a "hard-boiled" hat. Mike was struck on the head by a slab of coal weighing nearly 800 pounds and escaped with only a bruised leg and stiff neck. The impact of the falling slab was great enough to knock him about 8 feet from where he was working.

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2. An underground pipeman, Joe - - - - - , at the - - - - - mine, was working around the starting apparatus of an electrically operated pump, and in leaning forward his lamp came in contact with an open circuit-breaker in such a manner as to "short" the circuit breaker and cause a flash that destroyed his lamp. . . . Because of the insulating qualities of the hat, Mr. - - - - suffered no injuries or inconvenience other than the loss of his lamp.

3. A serious head injury was prevented in one case when a large piece of ore dropped from the back and struck the miner on the head. The top of the hat was caved in, but the miner received only a slight scalp wound.

4. At the - - - - - mine, February 5, 1930, Matt - - - - - , a driller, was wearing a pair of - - - - - goggles while breaking chunks of hard ore. A piece of ore flew up and hit one of the lenses . . . . The lens was hit almost in dead center, but remained intact in the rim; he was uninjured.

5. Two serious foot injuries were prevented by the use of hard-toed shoes; in both cases a large chunk of ore rolled down from the top of a dirt pile and struck the miners on the feet.

6. A man was dumping cars at a station. In righting the car, the body came out of its proper place and caught the man's foot against the frame. Although this was a lost-time accident, it was felt that the severity was considerably lessened by the use of hard-toed shoes.

7. One wheel of a coal car ran over a miner's foot. The hard toe of his shoe was considerably dented, but the foot was uninjured.

8. A coal miner was completely covered by a fall of slate, and although he suffered a fracture of the leg and numerous bruises, his head was not injured, due to the protection of a safety hat. In this case, the safety hat prevented what might otherwise have been a fatal accident.

9. A car dropped off the track on to the foot of a snapper. One toe was crushed so badly that it had to be amputated. However, had the snapper not been wearing safety shoes, it would probably have been necessary to amputate all the toes or part of the foot.

RESULTS ACCOMPLISHED BY THE USE OF PROTECTIVE CLOTHING

Obviously, it is impossible to procure complete records showing the results accomplished by the use of protective clothing; however, the results accomplished by a few companies whose records are available, show conclusively that the use of such clothing pays big dividends.

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A large eastern coal company operating three mines and employing about 1,600 men has made a remarkable reduction in eye and toe accidents during the past 4 years through the use of goggles and safety shoes. Safety hats have been introduced at these mines during the past year. The company did not enforce the use of goggles and safety shoes during 1929, but beginning in January 1930 every man entering the mines and all outside workmen were required to be equipped with safety shoes and goggles. The following tabulation shows the results that have been accomplished by this company in 3 years' time:

Accident reduction effected by wearing goggles and safety shoes

Eye Accidents

Year	Accidents	Days lost time	Frequency rate	Severity rate
1929	396	5,839	60.40	0.889
1930	150	3,793	24.42	.617
1931	55	79	14.43	.021
1932	17	13	5.56	.005

Toe Accidents

1929	164	1,129	25.02	.171
1930	72	510	11.72	.082
1931	20	530	5.27	.139
1932	5	54	1.95	.021

All accidents, including those in which no time was lost, are included in the foregoing tabulation. It is noted that the frequency of eye accidents has been reduced 91 percent and the severity has been reduced 99 percent. During these 4 years the record shows a reduction in the frequency of toe accidents of 92 percent, with a reduction in severity of 93 percent.

An anthracite company introduced safety hats at its mines; during 1929 about 10 percent of the employees were so equipped, but by 1932 about 95 percent were provided with safety hats. The use of safety hats at this property has reduced head injuries as follows:

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Accident reduction effected by wearing hard hats

Year	Head injuries	Days lost
1929	126	693
1930	142	1,319
1931	28	123
1932 to June 30	7	26

At an Ohio mine the accident record showed 16 lost-time accidents due to toe injuries during 1930. A safety campaign to induce all employees to wear safety shoes was started, and during 1931 only six toe injuries occurred; in 1932 when all the men were equipped with safety shoes, only one toe injury occurred.

A large anthracite company employing more than 11,000 men had 775 compensable eye injuries during 1931--12 percent of all the injuries for that year. During the latter part of the year, an educational campaign was started to teach the men the necessity of eye protection, with the result that 91 percent were provided with goggles and eye accidents were reduced more than 50 percent during 1932.

This company has reduced head injuries 75 percent within 2 years by the use of safety hats and has reduced toe injuries more than 50 percent during the same period by the use of safety shoes.

In a group of seven coal mines whose employees are nearly all equipped with safety hats, safety shoes, and goggles, some remarkable reductions have been made in the frequency and severity of head, foot, and eye injuries. An average reduction of 75 percent in the frequency of head and scalp injuries, a reduction of 96 percent in the severity of these injuries, has been made since the introduction of safety hats. The frequency of foot and toe injuries has also been reduced 75 percent, while the severity of these injuries has been reduced 93 percent. The frequency of eye injuries has been reduced 68 percent, while the severity has been reduced 43 percent. By the use of protective hats, shoes, and goggles, three of the companies of this group have practically eliminated all head, foot, and eye accidents in recent months.

The experience of copper and iron mining companies in the Lake Superior district has led to the more or less universal adoption of protective clothing as a safety standard; in many of the mines, the rule as to safety hats, shoes, and goggles is extended to visitors, no one being allowed to go underground without this equipment.

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The combined records of six large mining companies in the Lake Superior district whose employees are all equipped with safety hats, shoes, and goggles show that the use of such equipment is worth while. An average reduction of 68 percent in the frequency of head injuries and a reduction of 89 percent in severity of such injuries have been made since the introduction of safety hats. The frequency of foot injuries has been reduced 65 percent, with a reduction in severity of such injuries of 53 percent. The reduction in eye injuries in this district has not been as great, on the average, as it has been in some other districts, the frequency of eye injuries being reduced 6 percent and the severity 33 percent.

CONCLUSIONS

Both coal and metal mining companies are realizing the value of protective equipment, the wearing of which by all of their employees is required by many companies. With the increased use of protective clothing, a general reduction in the accident records may be expected.

The miner, the company, and the general public benefit by the use of protective clothing - the miner by avoiding the suffering from an injury and the loss of wages, the company by savings made in compensation and medical cost and by increased efficiency and morale, and the public by the decrease in costs of various kinds consequent to preventing men from being killed or maimed.

Statistics show that about 15 percent of the compensation cost in the bituminous mines of Pennsylvania during a 5-year period could have been prevented had the victims worn protective clothing. These statistics will probably apply, on the average, to mines in other States. Thus it is apparent that the saving in compensation alone is well worth the investment in protective clothing.

Although this report refers specifically to coal and metal mines, what has been said applies equally to nonmetal mines and quarries and also to certain "jobs" in mills and smelters. Many accidents in open-pit operations would have been avoided or lessened if goggles, hard shoes, and gloves had been worn. Head protection of some sort is also necessary in many if not most such types of work.

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